

Metropolitan Museum of Art Gas Chromatography- Mass Spectrometry (GC-MS) Results from Material Analysis

This document includes (1) a mass spectrum and (2) the volatile organic compounds (VOCs) emitted from samples using GC-MS analysis. The data is not interpreted; however, several classes of chemicals are highlighted because they are potential risks for artwork in an enclosed environment. A basic key, provided below, indicates those classes. The amount of each chemical identified has not been determined; similarly, it is not known how much of each chemical is necessary to do damage to art. Finally, peaks may be present that are the result of the sample adsorbing chemicals from the air and reemitting them during testing rather than being inherent to the sample. Research is ongoing to determine specifically which chemicals and amounts are required to negatively affect artifacts.

Highlighted data:

Pink – chemicals currently known to be hazardous to art

Green – amines; can raise the pH, are suspected to react with acids and may form crystals in an enclosed environment

Yellow – chemicals of the following type, which *may* be hazardous to art:

Acids – lower the pH, corrosive to metals, degrade organic materials

Aldehydes – can convert to acids with heat or exposure to UV light

Esters – can hydrolyze into acids with heat and humidity

Sulfur-containing compounds – known to tarnish and corrode some metals

Halogenated compounds – can become reactive with exposure to heat and UV light

Nitrogen-containing, not amine – can react with other off-gassed chemicals

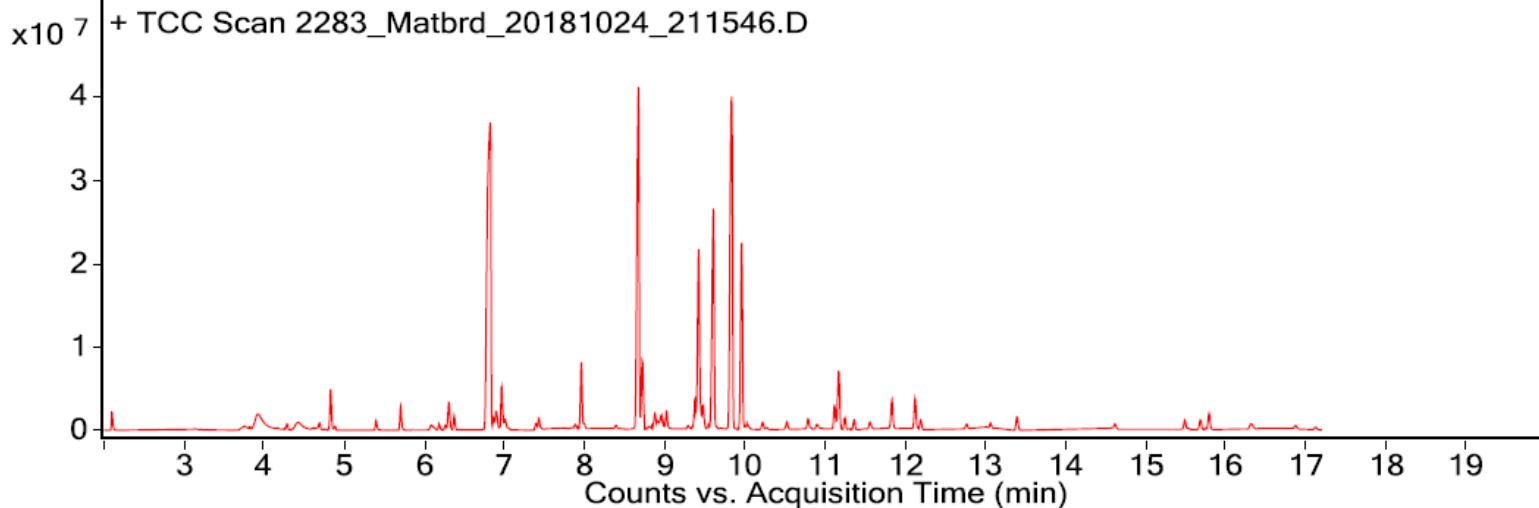
Alkynes – can become reactive when exposed to heat or UV light

Sample: Alpharag Artcare Museum 100% cotton mat board in ebony

Date collected: 10/23/2018

Technique used: SPME with a PDMS/DVB fiber; Agilent 7890B GC and 5977B MS fitted with a GL Sciences OPTIC-4 multimode inlet and LEAP PAL RTC autosampler; Pre-heated at 60°C for 20 minutes; fiber exposure at 60°C for 20 minutes; sample injected into 220°C inlet and crotrapped for 2 min at -15°C; GC ramped from 40°C to 225 °C at 10°C/min. Data analyzed in masshunter Qualitative. Samples > 80% match with a NIST 17.0 library are reported.

VOCs not highlighted are because they were also observed in blanks: (1) 4.8 min: methoxyphenyl oxime; (2) 11.6 min: 2-methyl-, 2,2-dimethyl-1-(2-hydroxyl-1-methylethyl) propyl ester propanoic acid; (3) 11.8 min: 2-methyl-, 3-hydroxyl-2,4,4-trimethylpentyl ester propanoic acid



Library results

RT	Score	Formula	MW	Area	CAS #	Name
1.530	97.2	C2H4O2	60.0	2377368	64-19-7	Acetic acid
2.100	91.4	C2H8O2Si	92.0	2657537	1066-42-8	Silanediol, dimethyl-
3.130	82.6	C7H22O2Si3	222.1	1366175	999238-34-3	1,1,1,3,3,5,5-Heptamethyltrisiloxane
3.760	82.4	C8H10	106.1	2569446	100-41-4	Ethylbenzene
3.930	97.6	C8H10	106.1	15451004	0-00-0	unidentified C2-benzene
4.290	97.2	C8H10	106.1	1104645	0-00-0	unidentified C2-benzene
4.430	95.9	C8H10	106.1	6241289	106-42-3	Benzene, 1,4-dimethyl-
4.690	95.2	C7H12O2	128.1	2299689	141-32-2	2-Propenoic acid, butyl ester
4.830	84.7	C8H9NO2	151.1	1086976	1000222-86-6	Oxime-, methoxy-phenyl-
4.830	97.0	C6H14O2	118.1	5830739	111-76-2	Ethanol, 2-butoxy-
5.400	96.5	C7H16O2	132.1	1675764	5131-66-8	2-Propanol, 1-butoxy-
5.700	97.8	C7H6O	106.0	4097814	100-52-7	Benzaldehyde
6.190	83.0	C14H26O3	242.2	892874	1000382-90-5	Carbonic acid, decyl prop-1-en-2-yl ester
6.260	87.3	C8H16O2	144.1	901944	109-21-7	Butanoic acid, butyl ester
6.310	96.0	C8H24O4Si4	296.1	5327080	556-67-2	Cyclotetrasiloxane, octamethyl-
6.370	97.1	C8H16O	128.1	2395373	124-13-0	Octanal
6.820	84.4	C10H22O	158.2	86278906	112-30-1	1-Decanol
6.900	82.2	C9H12O2	152.1	2185931	96392-56-2	1-Phenylpropane-1,2-diol
6.910	88.0	C9H18O2	158.1	1501447	999083-12-4	Octyl ester of formic acid
6.960	97.7	C5H9NO	99.1	5134825	872-50-4	2-Pyrrolidinone, 1-methyl-
7.390	96.0	C8H8O	120.1	1066094	98-86-2	Ethanone, 1-phenyl-
7.430	96.7	C8H18O	130.1	2141994	111-87-5	1-Octanol
7.880	89.4	C11H24	156.2	1319389	1120-21-4	Undecane
7.960	97.9	C9H18O	142.1	12444202	124-19-6	Nonanal
8.390	81.1	C11H20Cl2O2	254.1	901213	83004-99-3	Dichloroacetic acid, nonyl ester
8.670	96.7	C10H20O2	172.1	74840408	103-09-3	Acetic acid, 2-ethylhexyl ester
8.720	94.2	C10H30O5Si5	370.1	10742842	541-02-6	Cyclopentasiloxane, decamethyl-
8.970	86.7	C11H22O2	186.2	1233307	143-13-5	Acetic acid, nonyl ester
9.020	96.0	C10H20O	156.2	3420815	2216-51-5	Cyclohexanol, 5-methyl-2-(1-methylethyl)-, [1R-(1.alpha.,2.beta.,5.alpha.)]-
9.380	84.0	C12H26	170.2	2787116	112-40-3	Dodecane
9.420	95.2	C10H20O	156.2	25197166	937-05-3	Cyclohexanol, 4-(1,1-dimethylethyl)-, cis-
9.480	96.2	C10H20O	156.2	2260946	112-31-2	Decanal
9.610	95.7	C10H20O	156.2	50469156	21862-63-5	Cyclohexanol, 4-(1,1-dimethylethyl)-, trans-
9.840	88.4	C11H20O2	184.1	69789779	103-11-7	2-Ethylhexyl acrylate
9.960	91.5	C11H22O2	186.2	37325208	999145-46-3	2-Ethyl-1-hexyl propionate

10.220	82.7	C10H16N2	164.1	1625812	999094-51-6	2,3-Diethyl-2,3-dimethylsuccinonitrile
10.520	91.8	C14H30	198.2	1446666	61141-72-8	Dodecane, 4,6-dimethyl-
10.790	90.8	C13H28	184.2	2311245	629-50-5	Tridecane
10.900	80.8	C11H22O	170.2	1135126	112-44-7	Undecanal
11.120	93.2	C12H24O2	200.2	5180465	25415-84-3	n-Butyric acid 2-ethylhexyl ester
11.170	94.2	C12H36O6Si6	444.1	12214860	540-97-6	Cyclohexasiloxane, dodecamethyl-
11.250	86.3	C12H16	160.1	1490644	13065-07-1	Naphthalene, 1,2,3,4-tetrahydro-2,7-dimethyl-
11.360	84.3	C12H16	160.1	1994694	13065-07-1	Naphthalene, 1,2,3,4-tetrahydro-2,7-dimethyl-
11.560	82.0	C12H24O3	216.2	1661040	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
11.840	91.9	C12H24O3	216.2	6230052	74367-34-3	Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester
12.120	94.7	C14H30	198.2	5924067	629-59-4	Tetradecane
12.190	94.9	C13H12	168.1	2064257	643-58-3	1,1'-Biphenyl, 2-methyl-
12.770	87.1	C14H30O	214.2	1057990	112-72-1	1-Tetradecanol
13.060	86.7	C14H20O2	220.1	1288610	999234-71-6	2,6-di-butyl-2,5-cyclohexadiene-1,4-dione
15.490	84.9	C11H20O	168.2	2205865	99992-19-5	4a(2H)-Naphthalenemethanol, octahydro-